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STAFF APPRAISAL REPORT

KOREA

TECHNOLOGY ADVANCEMENT PROJECT

MARCH 1, 1989

Country Department II
Asia Regional Office

CURRENCY EQUIVALENTS

Currency Unit - Korean Won (W)

US$1.00 = W 680
(February, 1989)

WEIGHTS AND MEASURES

Metric System

FISCAL YEAR

January 1 - December 31

ACADEMIC YEAR

September - July

ABBREVIATIONS

CNB	-	Citizens National Bank
EMRD	-	Electronic Materials Research Division
FRG	-	Federal Republic of Germany
ICB	-	International competitive bidding
IFC	-	International Finance Corporation
ITC	-	Industrial Technology Center
KAIST	-	Korea Advanced Institute of Science and Technology
KDIC	-	Korea Development Investment Company
KERI	-	Korea Electrotechnology Research Institute
KIT	-	Korea Institute of Technology
KIET	-	Korea Institute of Electronics Technology
KTDC	-	Korea Technology Development Corporation
MTI	-	Ministry of Trade and Industry
MOST	-	Ministry of Science and Technology
OBF	-	Office of Business and Finance (KIT)
OPM	-	Office of Planning and Management (KIT)
O&M	-	Operation and Maintenance
OSROK	-	Office of Supply, Republic of Korea
PCR	-	Project Completion Report
PPAR	-	Project Performance Audit Review
R&D	-	Research and Development
SMI	-	Small and Medium Industry
SMIB	-	Small and Medium Industry Bank
SMIPC	-	Small and Medium Industry Promotion Corporation
SMIPF	-	Small and Medium Industry Promotion Fund
TSC	-	Technical Services Center (KERI)

KOREA

TECHNOLOGY ADVANCEMENT PROJECT

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This report is based on the findings of a preappraisal mission which visited Korea during May 18 - June 18, 1988 and an appraisal mission consisting of Mr. Rees (mission leader), Mr. Sung (technical educator, consultant) and Ms. N. Mattson (project cost analyst) which visited Korea during October 8-22, 1988. The appraisal mission was assisted by Mr. R. de Silva, Senior Country Officer.

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MAP

KOREA

TECHNOLOGY ADVANCEMENT PROJECT

Loan and Project Summary

Borrower:	Republic of Korea
Beneficiaries:	Korea Institute of Technology (KIT) Industrial Technology Center (ITC) Korea Electrotechnology Research Institute (KERI)
Amount:	US$16.4 million equivalent
Terms:	Payable in 15 years including 5 years of grace at the standard variable interest rate
Cofinanciers:	None
Project Description:	The project continues Bank assistance to technology development in Korea. Its broad aim is to strengthen the small and medium industry (SMI) sector in technology intensive fields and to improve the quality of education in a center of excellence producing scientists and engineers. The project would finance specialized equipment (base cost US$16.4 million) and complementary inputs comprising facilities to house the equipment (US$8.2 million) and the costs of installation, consumable materials and O&M expenditures (US$1.5 million) for three national institutions which play important roles in Korea's industrial/technological development--KIT, ITC and KERI. The project would: (a) improve the quality of science and engineering education and research at KIT by permitting greater focus on experimental and practical work and allow senior students to participate more fully in faculty research projects; (b) enhance the ability of ITC to provide advice and technical services to SMIs through strengthening basic R&D capacity, improving testing and inspection services and strengthening capacity to propagate low-cost automation techniques; and (c) enhance the ability of KERI to support the development of SMIs in the electrical industry through upgrading its R&D capacity to support the development of parts and materials for supply to major manufacturers.
Benefits & Risks:	The project would raise the quality of science and engineering education at KIT. This in turn would raise the quality of inputs to graduate programs and ultimately benefit technology-intensive industry. The project would also strengthen the capacity of ITC and KERI to provide

technical advice and services to SMIs which would result in better utilization of scarce technical manpower and improve the quality of products. The SMIs would serve more effectively as suppliers of parts and materials to large enterprises thus reducing imports. The export capacity of SMIs would also be enhanced. There are no major risks associated with the project.

Project Costs:

	Local	Foreign	Total
	----- (US$ million) -----		
Korea Institute of Technology	2.5	5.4	7.9
Industrial Technology Center	3.7	8.6	12.3
Korea Electrotechnology Research Institute	1.9	4.0	5.9
Baseline Cost	8.1	18.0	26.1
Contingencies			
Physical	0.9	1.8	2.7
Price increase	0.3	0.9	1.2
Subtotal	1.2	2.7	3.9
Total Project Cost /a	9.3	20.7	30.0

Financing Plan:

	Local	Foreign	Total
	----- (US$ million) -----		
Government	9.3	4.3	13.6
IBRD	-	16.4	16.4
Total	9.3	20.7	30.0

Estimated Disbursements:

Bank FY	1990	1991	1992	1993
	---------- (US$ million) ----------			
Annual	5.4	5.8	4.4	0.8
Cumulative	5.4	11.2	15.6	16.4

Economic Rate of Return: Not applicable

Map: IBRD No. 21409

/a Does not include duties, taxes and fees estimated at US$1.5 million.

KOREA

TECHNOLOGY ADVANCEMENT PROJECT

I. TECHNOLOGY DEVELOPMENT IN KOREA

A. Introduction

1.1 Korea has experienced remarkable industrial development over the past quarter century characterized by increasing diversification and strong export orientation. Manufacturing output grew at about 15% p.a. during 1960-85 and accounted for 42% of total output by 1985. This rapid industrialization was based on superior labor productivity and organizational skills and was focussed initially on light industrial goods such as textiles, apparel, leather and wood products. In the early 1970s, policies shifted towards deepening Korea's industrial base through emphasis on heavy and chemical industries. As exports in the traditional, labor intensive industries started to decline, the 1980s have seen another shift in industrial policy towards technology-intensive development in electronics, transportation equipment and fine chemicals. The industrial restructuring policy aims to develop and utilize technology to the fullest in order to gain continued improvements in labor productivity and to expand high value added output which is technologically sophisticated, energy efficient and strongly export-oriented.

1.2 Underlying these developments has been a strong commitment by the Government to technology promotion. This has been achieved through the rapid development of R&D capacity by means of expanding higher education institutions for training scientists and technologists and the development of national research institutes--nine of which now exist. At the same time incentives were provided to the private sector to expand R&D expenditures (tax incentives, accelerated depreciation etc.) with the result that its share of total R&D expenditures had risen to two-thirds by 1985 compared with less than one quarter in 1970. The Government has also made a strong commitment to the development of small and medium industries (SMIs) to play a pivotal role in expanding the industrial base. An enhanced role for SMIs will reduce industrial concentration and the reliance of large enterprises on imported parts and materials, improve regional growth, expand employment and increase exports.

1.3 These policy trends help to identify three major areas of critical importance to Korea's industrial transformation. First, the need to continue to upgrade R&D if Korea is to retain its competitive edge in export markets; second, the need to progressively upgrade and restructure skill mix requirements to ensure that skills are relevant to the demands of an increasingly technology-intensive market; and third, the promotion of SMIs as suppliers of basic materials and parts to larger industrial enterprises and as self-reliant export industries. The proposed project will assist in achieving the Government's objectives in all three areas.

B. Research and Development

1.4 The growth of R&D in Korea was led by the establishment of a number of public sector research institutes from the mid-sixties to the late-seventies. These institutes were established to concentrate scarce technological manpower and optimize its utilization, strengthen the technological infrastructure and as centers of excellence to stimulate R&D, provide technical advice and services to industry and to encourage the return of Korean scientists and engineers working overseas. By 1981, sixteen institutes had been established and these were reduced to nine in a rationalization program to optimize the use of research staff and equipment. The R&D effort, which initially was largely government-financed, became increasingly private as tax and other financial incentives began to make an impact in the late 1970s. By 1980, nearly 50% of R&D expenditures were undertaken by the private sector and this proportion had reached 66% by 1985. This growth is reflected in the development of private R&D institutes which increased from 43 in 1979 to 455 in 1987. Total R&D expenditure has increased dramatically from 0.6% of GNP in 1980 to 2% in 1986 and is planned to reach 3% by 1991 and 5% by 2001.

1.5 The universities have also played an important, if subsidiary, role in the growth of R&D activities. While the universities have a preponderance of graduate R&D manpower, limited research funds have kept per capita research spending at only about one-quarter that of industry and one-sixth that of the research institutes. Financial constraints have also led to shortages of research equipment which have hampered both the quantity and quality of research. The result of resource constraints in the universities compared with the more generous endowments in industry and in the research institutes has been a bias in favor of applied rather than basic research. This has clearly had short term benefits for industry, especially in the export sectors, but a long term commitment to expanding and improving basic research is the key to sustained technological development. This has been recognized by the Government in its priority to build up a small number of graduate institutions as centers of excellence in research, comparable to the Korea Advanced Institute of Science and Technology (KAIST) (para. 1.14). Emphasis is being placed on recruiting top-level research scientists and engineers and providing state-of-the-art research facilities.

1.6 The growth of R&D efforts has been impressive and Korea now compares favorably with industrialized countries in terms of the proportion of GNP allocated to R&D. However several problems are evident. First, in spite of a rapid expansion of R&D manpower, which nearly tripled in 1980-86, the number of Korean researchers per ten thousand population was little more than one third the number in Japan and the United States. The Government plans to raise the ratio of scientists and engineers from 13 per 10,000 population in 1986 to 30 per 10,000 by 2001, a level comparable to that of the U.S. and Japan in 1985. To achieve this goal, Korea will need to employ about 150,000 scientists and engineers by 2001 compared with 52,000 in employment in 1986. This will require the continued rapid expansion of enrollments in science and engineering programs especially at the graduate level together with a strong commitment to improving the quality of graduates. Quality has emerged as a crucial problem and is being addressed through programs to modernize equipment, upgrade teaching staff and reduce teaching loads and teacher/student ratios (para. 1.14). At the graduate level, the move to develop a small

number of institutions as centers of excellence will raise the standards of teaching and produce better quality graduates. These efforts are being assisted under the Bank's Second Education Sector Loan (Loan 2427-KO).

1.7 Second, although the public research institutes have served a useful purpose as a training ground for researchers who ultimately work in industry, their ability to meet industry's growing and complex technical needs has been limited by inadequate staffing and outdated equipment. Only a small percentage of industry's R&D is contracted to the institutes despite encouragement from the Government. Furthermore, the research institutes have not been able to offer systematic technical advice and services to industry, especially the SMIs, which are most in need of such services. To strengthen the link between industry and the public research institutes, the Government has introduced a program of "National Projects" to develop broad technological infrastructure in priority areas such as semiconductors, computers, fine chemicals, materials science etc. The National Project scheme includes industry-initiated research projects which are mainly joint ventures between SMIs and an institute. The program was funded at US$111 million in 1986 with nearly one half being financed by the private sector. To ensure sound selection and implementation, projects are appraised by the Korea Technology Development Corporation (KTDC) which is the beneficiary of three Bank loans (Loans 2122-KO, 2473-KO, 2913-KO).

1.8 Third, Government policy to encourage R&D investments by industry has emphasized the need to create suitable financing mechanisms for R&D activities, especially for SMIs. In response to this, recent legislation has been passed to provide venture capital for the formation of SMIs viz. the Small and Medium Industry Inauguration Assistance Act and the Venture Business Financial Support Act. These acts responded in particular to the perceived weakness of the component industries serving key industrial subsectors such as electronics and automobiles, which are heavily dependent on imported parts and materials. The first act builds upon the successful experience of KTDC to foster the formation of private venture capital companies to stimulate the establishment of new industrial firms. Nineteen financing companies now exist and they invested US$42 million in 208 companies in 1987. The second act was enacted to promote the use of new instruments and new sources of financing for technology development including expanded use of conditional loans and equity investments.

C. Science and Technology Education

1.9 Education has played a major role in Korea's development as the country sought first to create a literate population and then to develop higher levels of education and skills as a basis for rapid economic growth. Consequently, in the decades after independence in 1948, the education system grew rapidly with enrollments increasing 2.5 times between 1960 and 1987. As a result, nine years of compulsory education has been achieved, over 80% of the secondary age group (12-17 years) is enrolled and about 40% of the 18-22 years age group are attending post-secondary institutions. Such a rapid expansion inevitably led to a decline in the quality of education, especially in the overcrowded urban areas, and the 1970s saw the beginning of an era of consolidation and qualitative improvement. Teacher training was improved and expanded, class sizes reduced and curricula upgraded. These improvements were

facilitated in the primary and middle schools in the 1980s by declining enrollment levels due to falling population growth rates. The quality improvement programs are still being implemented and higher levels of student achievement are being recorded.

1.10 Education at the secondary and higher levels in Korea has always borne a close relationship to the development of the economy, especially its emphasis on industrial growth and restructuring. In the 1960s, when labor intensive light industries required large numbers of skilled workers, enrollments in vocational and technical schools increased rapidly. The change of emphasis to heavy and chemical industries in the seventies shifted demand to higher technical education and enrollments grew accordingly in junior vocational colleges (for training technicians) and science and technology programs in the universities. At the same time, enrollments in the vocational and technical schools started to decline as the demand for manpower shifted to higher skill levels. The development of technology-intensive industry in the 1980s has led to the expansion of graduate programs in science and technology while enrollments in the junior vocational colleges and in undergraduate programs have levelled off. The latter is due partly to a change in the structure of manpower demand but also to a realization that the rapid expansion of the seventies and eighties had led to a deterioration of quality in higher education. Thus consolidation and quality improvement were called for rather than continued expansion of undergraduate programs.

1.11 The foundation of education in science and technology is to be found in the 800 general high schools which offer science majors comprising mathematics and the natural sciences. There are also five specialized science high schools with a total enrollment of about 700. These elite schools were established to discover gifted children in science and to educate them in a rigorous academic environment. Admission is highly competitive and early entry to university is permitted for the best students. However in the general high schools, the overall quality of science education is still a cause for concern. Class sizes, of around 50 students, are too high; too little time is devoted to practical work with the result that experimentation skills are weak; course work remains test-oriented, focussing on the rote learning necessary to pass the aptitude tests for university entrance; and many science teachers lack adequate training in their subjects. These issues are crucial because it is in the secondary schools that the foundation for the higher study of science and technology is established and weaknesses here are carried through to the universities. This has been recognized by the Government and the problems are being addressed through a comprehensive improvement program. A new experiment-oriented curriculum is being introduced and university entrance is being broadened to include high school grades in addition to aptitude test scores; a retraining and upgrading program for science teachers is being implemented and laboratory assistants are being recruited to assist teachers in laboratory work; laboratory facilities are being expanded and re-equipped. The Korea National University of Teacher Education has been established to train high level science educators and to serve as a center for innovation and research in teacher education. These efforts are being assisted under the second education sector loan (Ln. 2427-KO).

1.12 About 100 colleges and universities offer degree programs in science and technology with enrollments of about 360,000. This represents about 36% of total undergraduate enrollments. At the graduate level, about 19,000 students are enrolled in science and technology programs which represents about 27% of total graduate enrollments. At the apex of science and technology education is the Korea Advanced Institute of Science and Technology which was established in 1970 as a center of excellence for graduate education and research in science and technology. KAIST has achieved its planned preeminent status by attracting the highest quality faculty and researchers, including many repatriated Koreans, to well equipped and financed laboratories. KAIST is at present being restructured with the teaching part being transferred to a new campus at Daeduk Science Town while research activities remain at the existing campus in Seoul. However, research by faculty at Daeduk will continue to receive appropriate emphasis in order to attract top-quality faculty to Daeduk. To date, KAIST has graduated over 5200 students with higher degrees including nearly 500 with doctorates.

1.13 KAIST will draw talented students increasingly from the Korea Institute of Technology (KIT) which was established in 1986 as a center of excellence for the undergraduate education of scientifically gifted students. When fully enrolled, KIT will have about 2000 students. Entry is highly competitive with a significant proportion of the entering class of 540 being drawn from the science high schools. Most students are oriented towards graduate school - a recent study indicated that about 80% intended to pursue further study mainly at KAIST. Thus there is a discernible link developing between the elite institutions which draw highly talented students from the science high schools through KIT to KAIST. The Government is looking to these graduates to staff the graduate schools and research institutes in the future and to provide the leadership for the continued development of high technology processes.

1.14 Nevertheless, in spite of much progress, higher education is not free of problems. The rapid expansion of the seventies and eighties brought to higher education the same problems of declining quality as afflicted the school system. This was especially so in science and technology programs which are heavily dependent on properly equipped and up-to-date laboratories and highly trained faculty. Quality varies widely among the 100 higher institutions offering science and technology programs but standards are high in only a handful of leading universities. Elsewhere, qualified faculty are in short supply leading to heavy teaching loads, student/teacher ratios are too high (e.g. averaging 38:1 in engineering colleges), expenditures on facilities and equipment have not kept pace with enrollments and faculty research funds are limited. The Government is addressing these issues by expanding faculty recruitment to reach an average student/teacher ratio of 20:1 and an average weekly teaching load of 10 hours by 1990, increasing research funds and upgrading laboratories. In addition, the Government has targeted a small number of graduate schools to be developed to standards similar to KAIST's to support the momentum in the growth of technology-intensive industry in Korea. Support for these efforts is being given under Loan 2427-KO.

D. Small and Medium Industry

1.15 Korea's spectacular economic growth has been led by a relatively small number of conglomerates which dominate the economy--the dozen leading groups currently account for nearly one-quarter of GNP. Large enterprises have spearheaded the export drive and the rapid development of R&D activities which underlie it. In contrast is the small and medium industry (SMI) 1/ sector which comprises over 50,000 enterprises, employs the majority of industrial workers and makes a significant contribution to manufacturing value added. The major light industries in the SMI sector are textiles (accounting for 21% of the total SMI value added) and food (12%) while the heavy and chemical industries are machinery (24%) and chemical products (18%). SMIs dominate in such subsectors as wood products and furniture, paper products and printing, non-metallic minerals and other manufactured goods, contributing more than half of each subsector's value added. As might be expected, there is also concentration in the SMI sector--enterprises which employ more than 50 workers account for about 15% of establishments but produce 70% of the SMI sector's total value added.

1.16 The role of small and medium industry in the Korean economy experienced a period of decline in the sixties and seventies but the trend has now been reversed. In 1963, SMIs employed 62% of the manufacturing workforce and generated 50% of value added; by 1975 this had declined to 46% of employment and 32% of value added. This decline was due in part to the growth of successful SMIs into large-scale enterprises but more importantly to Government policies which favored large enterprises and hampered the access of SMIs to credit, financial incentives and other necessary resources. A change in Government policies in the mid-seventies has reversed this trend. The SMI sector has gradually recovered lost ground and by 1984 SMIs accounted for 55% of manufacturing employment and 36% of value added.

1.17 The Government's objectives in promoting SMIs in Korea's industrial development are set out in the Sixth Plan (1987-1991) and are based on several considerations. First, there are considerable efficiency gains to be achieved through the vertical integration of SMIs in the productive process as suppliers of parts and materials to large-scale enterprises. Traditionally, the large enterprises have manufactured their own parts and materials or imported them, especially in such major industrial subsectors as electronics, machinery, automobiles and shipbuilding. The development of SMIs as specialized suppliers will broaden the technological base of industry, expand the employment of technical manpower and improve local self-sufficiency and the balance of payments through the replacement of imports. Second, the expansion of SMIs will contribute to the strategy of balanced regional development. Small scale industry is at present heavily concentrated in the Seoul and Pusan areas and the Government is developing special regional industrial estates to encourage the decentralization of industry. The SMIs, through their flexibility in scaling outputs and their less complex infrastructure requirements, lend themselves more easily to the dispersal of industrial activities. Third, the need to develop technology-intensive industries has been felt increasingly in Korea in order to continue to improve international competitiveness. With their adaptability to changing technology and market conditions, technology-

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1/ An SMI enterprise is generally defined in terms of both employment size (less than 500 employees) and assets (less than Won 4 billion).

intensive SMIs are expected to play a dynamic role in the drive for increasing sophistication in the Korean manufacturing sector. This process of technology-deepening will complement the process of technology-broadening mentioned above.

1.18 In support of the SMI sector, the Government has established an elaborate legal and policy framework to identify promising enterprises with high growth potential, increase financial assistance, strengthen the linkage between SMIs and large-scale industry and improve product quality. Within this framework, the role of SMIs in industrial development will be significantly enlarged in the Sixth Plan period. The average annual growth rate of the SMI sector is projected at 11% during the period compared with 8% for the total manufacturing sector. The share of SMIs in the manufacturing sector's total investment is projected to increase from 30% in 1986 to 42% during 1987-1991. In order to achieve the substantial increase in the contribution of the SMIs to investment, the Government will need to sustain its institutional support and increase financial resources available to the SMIs.

1.19 In order to develop leaders with high growth potential in the SMI sector, the Government introduced a small-business "incubator" program in 1983. Each year about 1,000 SMI enterprises have been selected for special Government assistance in the form of increased consulting services and access to a special US$ 250 million soft loan fund. The program, run by the Ministry of Trade and Industry (MTI), has been a success at least in terms of its contribution to exports. Enterprises selected for the program increased exports by 34% p.a. during 1983-86 compared with an increase of 12% p.a. for all SMIs.

1.20 The financing of a major part of SMI credit is the responsibility of several specialized institutions. In addition to the venture capital companies (para. 1.8), a special promotion fund and two specialized banks service the SMIs. The Small and Medium Industry Promotion Fund (SMIPF) was established by the Government to address the imbalance in access to long-term credit which had favored large-scale enterprises in the 1970s. By 1984, the SMIPF accounted for about 10% of the total SMI investment financing. Long-term credit is also provided by the Small and Medium Industry Bank (SMIB) and the Citizens National Bank (CNB). The SMIB serves small and medium enterprises while the CNB serves only small enterprises (less than 100 employees) as well as household consumers. The two banks finance about half of the SMIs' long-term capital requirements. Short-term financing is provided mainly by the commercial banks which are required to allocate about a quarter of their incremental lending to SMIs. About 75% of short-term SMI loans outstanding in 1984 were financed by commercial banks.

1.21 The conglomerates, which dominate Korean manufacturing are vertically integrated and produce a high proportion of the domestically-produced parts and materials. Consequently, the link with SMIs as subcontractors is poorly developed in Korea. Many subcontractors are small, operate with inadequate facilities, lack adequate managerial and technical skills and are often subject to disadvantageous arrangements with the prime contractors. The Government has recognized that subcontracting is critical to the efficient development of manufacturing since the competitiveness of large end-producers and of the subsectors as a whole depends heavily on close working relationships with suppliers of parts and materials. To strengthen these links, the

Government has enacted laws to promote subcontracting including specifying various parts to be manufactured exclusively by subcontractors and designating certain contracting subsectors to receive intensified technical assistance and credit.

1.22 The successful integration of SMIs as suppliers of parts and materials requires a significant improvement in the quality of their products. Traditionally, SMIs have suffered from lack of technical expertise and limited access to credit. The situation has improved as the technical education system has expanded and credit improved through a number of special Government initiatives. The Government is also committed to providing institutional support for SMIs to facilitate their ability to absorb and use productively new technological improvements. There is also a need to resolve common technological problems such as metal forming and casting, automation etc. which cannot be resolved by individual SMIs. This requires improved technical advice and services from the Government and the R&D institutions. In addition, raising product quality will require strengthening quality control and certification processes in the SMIs.

E. Bank Role in Technology Development and Skills Advancement

1.23 The Bank has supported technology development through direct assistance in promoting R&D as well as through an active dialogue with Government on technology policy and institutional issues. The Bank's first direct involvement in technology development was in 1979 with Bank financing for the Electronics Technology Project (Loan 1676-KO) which aimed at strengthening the capacity of the Korea Institute of Electronics Technology (KIET) to lead industry in acquiring and developing semiconductor technologies and provide support services in R&D, technical training and the identification of overseas market opportunities. The draft project completion report (PCR) for the project indicates that the rapid development of the private semiconductor industry in the early 1980s largely obviated the need for the services that KIET aimed to supply. As a result, KIET did not become a profit-making, self-financing institution with a leadership role as envisaged at appraisal. Nevertheless, the PCR concludes that KIET probably did play a useful catalytic role in showing the Korean electronics industry that the acquisition of advanced technologies and capabilities was feasible.

1.24 Assistance to the electronics industry was followed by two projects which provided direct support for strengthening SMIs. Loan 2215-KO assisted the Small and Medium Industry Promotion Corporation (SMIPC) in expanding technical assistance and training services to SMIs in the machinery subsectors and in the provision of credit to SMIs through several financial intermediaries. The credit component was not fully disbursed due to the availability of local credit at more competitive rates. However, the technical assistance and training components were implemented satisfactorily. Preparation of a PCR for this project is about to commence. Loan 2515-KO is providing further support to SMIPC's technical assistance and training activities, expanded and improved credit services and the strengthening of subcontracting arrangements between SMIs and large contractors.

1.25 Three loans to KTDC (Loans 2122-KO, 2473-KO, 2913-KO) sought to fill a gap in the financial system by providing assistance for risky technology-

intensive industrial R&D projects. The IFC has also made an investment in the Korea Development Investment Company (KDIC), a venture capital company which invests, inter alia, in the commercialization of new technology. These technology-financing projects are in line with Bank recommendations to move industrial policy away from one in which the Government takes the lead in "picking winners" towards one which emphasizes intervention in functional areas such as R&D and the development of SMI and venture capital, where market imperfections and externalities exist.

1.26 The Bank has provided more general support for financing industrial development through three loans to the Korea Long-Term Bank, one loan to the Korea Development Bank and one to SMIB.2/ The project performance audit reports (PPARs) for these projects conclude in all cases that the Bank's objectives of resource transfer and institution building were achieved satisfactorily. Underlying these operations, the continued dialogue between the Bank and the Government on Korea's industrial development has resulted in the preparation of a number of important reports including Managing Korea's Industrial Transition (Report No. 6138-KO; July 31, 1986). This report helped the Government think through its program for trade and financial sector liberalization as well as industrial policy.

1.27 To complement direct assistance and financial and institutional support for technology development, the Bank has financed six loans to assist the development of technical manpower. The restructuring of industry towards more skill-intensive, high-technology production requires the continuous expansion and upgrading of technical skills. Bank lending in education has closely paralleled the increasing sophistication of the Korean economy. The Bank's initial involvement in the sector under four loans/credits, focussed on the development of vocational and technical education at the secondary and postsecondary levels to build a firm base to the system for producing technical manpower. PPARs for these projects concluded that they were in general well-conceived and successfully implemented. The reports also concluded that future projects would benefit from: (a) advanced project preparation before approval; (b) improved local management procedures to expedite procurement; and (c) greater focus on policy-analysis and evaluation. These lessons were built into the two subsequent operations which were policy-oriented sector loans.

1.28 The first of the education sector loans (Loan 1800-KO), concentrated on upgrading junior technical colleges and university colleges of engineering and management through the supply of equipment, staff development and institutional improvements in curriculum development, manpower planning, equipment maintenance and academic accreditation. The draft PPAR for the loan indicates that the major lessons learnt were: (a) a stable and responsible sector management agency was the key to successful implementation of the sector program; (b) the sector approach led to a quicker and more sustainable development of institutional capabilities; and (c) the additional time required for preparation was repaid in terms of more efficient implementation. The second sector loan (Loan 2427-KO), which incorporates these lessons, is supporting improvements in graduate education in science and engineering, upgrading secondary school and college science programs, expanding graduate

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2/ Respectively Loans 735-KO; 904-KO; 1145-KO; 1095-KO and 1175-KO.

research programs and improving sector management, manpower monitoring and strengthening the financial base of private educational institutions. Implementation of the loan is proceeding satisfactorily. The Bank's positive role in Korea's education sector is documented in the OED report titled Review of the Impact of World Bank Lending for Educational Development in Korea (Report No. 5950; December 4, 1985).

II. THE PROJECT

A. Origin of the Project

2.1 The Government included the project in its FY89 list of projects suitable for external financing and formally asked the Bank for assistance in December 1987. In the same month a Bank mission identified the project. Most of the preparation work was completed by the Government according to information requested by the Bank. The project was preappraised in May-June 1988 and appraised in October 1988.

B. Project Rationale, Objectives and Scope

2.2 The Bank has been assisting technological development in Korea over the past decade in a series of operations which have been consistent with the Government's priorities (paras. 1.23-1.28). The Bank inter alia has provided direct support to SMIs and substantial assistance in financing risky R&D projects; major assistance has also been provided for the development of technical and scientific education including two sector loans which have contributed significantly to developing a sound policy environment in the sector. The proposed project continues support in these areas by addressing the needs of three national institutions which the Government has identified as requiring additional quality-improving investments and which the Bank, with its long experience of assistance to education and technology development in Korea, is well-qualified to provide. Furthermore, since Bank experience in lending for technology development is relatively limited, the project offers an opportunity for the Bank to learn lessons from the Korean experience which can be utilized elsewhere.

2.3 The broad aim of the project is to continue to strengthen the development of SMIs in technology intensive sectors by enhancing the capacity of two R&D institutions to provide technical support to SMIs; the project would also improve the quality of education in a center of excellence in science and engineering education. The project would assist in strengthening Korea's ability to retain its competitive edge in export markets, contribute to providing high-level skills which are relevant to an increasingly technology-intensive market and support the development of SMIs as suppliers of basic parts and materials. More specifically, the project would finance specialized equipment through the Bank and complementary inputs (mainly civil works) to be financed by the Government to:

(a) improve the quality of science and engineering education and research at KIT by permitting greater focus on experimental and practical work and to allow senior students to participate more fully in faculty research projects;

(b) enhance the ability of the Industrial Technology Center (ITC) to provide advice and technical services to SMIs through strengthening basic R&D capacity, improving quality testing and inspection services and strengthening capacity to propagate low-cost automation techniques; and

(c) enhance the ability of the Korea Electrotechnology Research Institute (KERI) to support the development of SMIs in the electrical industry through upgrading its R&D capacity to support the development of parts and materials for supply to major manufacturers.

C. Project Description

Korea Institute of Technology (Estimated baseline cost US$7.9 million)

2.4 KIT was established in 1986 as a center of excellence for the undergraduate teaching of science and engineering. It has an intake capacity of 540 students and when fully enrolled in 1989, it will have about 2,000 students. Entering students are of high quality with a significant proportion coming from among the best students in the specialized science high schools. The remaining students, who are drawn from general high schools must be in the top 10% of their class. All candidates must take an entrance examination and there is a 3:1 application-to-entry ratio. About 10% of enrollments are female and KIT is giving special emphasis to enlarging female enrollment.3/ The student/faculty ratio is a satisfactory 10:1. Most of the faculty are repatriated Koreans, trained overseas and are of high quality. In areas where staff lack industrial experience, adjunct professors are employed as part-time teachers drawn from industry. In order to keep staff skills and knowledge up to date, about 10% of staff are sent overseas for training annually. This is financed from KIT's recurrent budget.

2.5 KIT has three schools of engineering (electrical, mechanical and applied), a school of natural sciences and a department of humanities. Courses are of four years duration and about 20% of course work is in the humanities including languages. A detailed organization chart is included in Annex 1. Early specialization has been avoided by having a common first year covering humanities and basic science/math courses. Practical work in the laboratory and workshop is emphasized and all graduates in applied engineering must have completed eight weeks of work experience in industry. This experience is optional for other engineering programs. Although an undergraduate institution, KIT places considerable emphasis on research and has three affiliated research institutes for robotics, mathematics and the education of scientifically-gifted students. Basic research is undertaken within the institution and also in association with outside institutions, especially KAIST which is currently moving from Seoul to a campus adjacent to KIT. Because KIT has no graduate students, senior students are being given increasing opportunities for direct involvement in research projects. A recent survey indicated that about 80% of KIT's students wished to pursue graduate degrees at KAIST after graduation.

3/ Female enrollment in undergraduate courses in science and engineering Korea-wide is 15.7% with 40.4% in natural sciences and 4.2% in engineering.

2.6 Physical facilities at KIT are about 95% complete with the remaining dormitory and laboratory facilities scheduled for completion by 1990. Laboratories are partly equipped. It is estimated that about US$13 million of equipment has been installed out of a total program of US$24 million. The proposed project would finance US$5.4 million of equipment (excluding contingencies), thus meeting about half the cost of the remaining equipment requirements of about US$11 million. The items of equipment have been reviewed in the rigorous internal review system at KIT and are relevant to the institution's priority needs. Bank financed equipment would be placed partly in existing laboratories and partly in planned new facilities. It is estimated that new construction to house Bank-financed equipment would cost about US$1.9 million plus contingencies. The project would also finance the costs of transportation and installation of equipment, consumable materials and O&M expenditures associated with the equipment.

Industrial Technology Center (Estimated baseline cost US$12.3 million)

2.7 ITC's major objectives are to strengthen the foundation of industrial technology through R&D activities and to provide technical advice and services to the SMIs. Since large-scale enterprises mostly undertake their own R&D functions, the R&D efforts of ITC are largely directly towards small and medium industries. These efforts involve the design of new products which can be manufactured by SMIs with payment of royalties to ITC. ITC also provides technical advice to SMIs aimed at raising their productivity especially through the introduction of low cost automation processes. In the field of services, ITC plays an important role in testing the performance of products and certifying their quality. ITC is responsible for testing products for the Office of Industrial Promotion which issues the "Korean Standards" stamp certifying that a product has met exacting standards of performance. The latter are particularly important for export products and, to maintain an understanding of international standards, ITC maintains official relations with a number of overseas standards agencies. Thus ITC has a direct effect on raising the quality of SMI products which are mainly components targeted for sale to large manufacturers. This raises the competitiveness of local component producers and over time will reduce imports of components. Royalties and fees for the above services account for about 60% of the annual budget of ITC and this proportion is gradually increasing.

2.8 ITC has a professional/technical staff of 251, growing at about 5% p.a. ITC has a well-defined overseas training program for 1988-91 of about 12 study years financed mainly by UNIDO, the Federal Republic of Germany (FRG) and Japan. FRG's component includes 4-6 study-years for the promotion of SMIs and 2 study-years for dies and molds engineering training. A technical assistance program providing about six staff-years of overseas experts in dies and molds technology is also financed by the FRG. These programs support the main thrust of ITC's R&D activities in materials casting and moulding which aim at a more economical use of metals and other materials such as plastics and polymers. ITC's operations are grouped in seven departments (Annex 2) of which five are the focus of R&D and testing activities.4/ High quality dies

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4/ Mechanical, Electrical and Standards Testing and Research Departments; Precision Machines Department; Castings Research Department.

and molds are developed in the Precision Machines Department for use by SMIs (or large enterprises) and the design and quality of cast products improved in the Castings Research Department. The Enterprise Support Department assists SMIs to assimilate new technology and to improve productivity through automation. The Export Certification Department ensures that products for export meet international standards (para. 2.7).

2.9 The items of equipment to be financed under the project (US$7.0 million excluding contingencies) have been reviewed within ITC, taking into account existing equipment and are appropriate to the operations and activities of ITC. Basic R&D in dies and molds in the Precision Machines Department would be supported by US$1.3 million (19%) of equipment. Foundry equipment (US$0.9 million or 13%) would be supplied to the Casting Research Department. Quality certification would be improved in the three Testing and Research Departments through the provision of US$2.8 million (40%) of equipment. Foreign quality certification would be improved (US$1.2 million or 17%) and support for ITC's ability to assist in the development of low cost automation techniques would be enhanced by the provision of US$0.8 million (11%) of equipment. Project-financed equipment would be placed in several locations. ITC is planning a new building on the present campus due for completion in early 1990, with about 70% of its floor area devoted to laboratories for research, development and testing. These facilities would house about US$2.5 million of project-financed equipment and are estimated to cost US$4.2 million. Two additional buildings with an estimated total cost of US$0.3 million would be built to house the EMC Anechoic Chamber (US$1.1 million) and the Explosion Proof Testing System (US$0.5 million). The remaining equipment (US$2.9 million) would be housed in existing buildings at ITC. The total cost of civil works related to the project is US$4.5 million excluding contingencies. The project would also finance the costs of transportation and installation of equipment, consumable materials and O&M expenditures related to the equipment.

Korea Electrotechnology Research Institute (Estimated baseline cost US$5.9 million)

2.10 KERI was established in 1976 to serve the research and development needs of the electrical manufacturing industry and the electric power generation and distribution system. The more efficient utilization of electrical power is also within its responsibilities. KERI has a highly qualified staff of 273 of which nearly half have graduate degrees. A staff training program finances about five staff members annually to pursue doctorates and upgrades about six per annum to the bachelor's level. The organization of KERI is shown in Annex 3. Five operations divisions and three specialized centers form the core of KERI's activities which cover research and testing in power systems and the development of electrical materials. It is in the latter field that Bank-financed equipment will be concentrated. The outreach arm of KERI which provides technical assistance to the electrical industry is the Technical Services Center (TSC) which includes a technical information library. The TSC is supported by the other divisions and centers which provide technical advice and support to industry. Such technical assistance, organized by TSC in conjunction with the other divisions, includes field support and in-factory assistance, test analysis, technical training, techni-

cal information and support for the design and production of new or improved products. Income from these services accounts for about 62% of KERI's annual budget. A long-term development plan for KERI calls for full self-financing to be achieved by 2001.

2.11 KERI services the whole of the electrical industry but is increasingly focusing on SMIs as producers of basic materials and parts for the large manufacturers. The SMI sector producing intermediate products is not well developed in the Korean electrical industry with the result that the industry is increasingly dependent on imports of materials and parts. The ratio of import dependence has increased from a low of 42% in 1984 to 53% in 1986. Priority is therefore being given to the development of KERI's basic R&D capacity to develop basic materials for manufacturing of electrical parts in the SMIs. This effort is focused in the Electric Materials Research Division (EMRD) which would be the recipient of the Bank-financed equipment. The EMRD currently has a staff of 27, all with graduate degrees. Staffing is being expanded to a full complement of 49 professionals of which 90% will have graduate degrees. EMRD is currently supporting a wide range of R&D activities in association with SMIs including the study of heat treatment in ceramics development, design of improved power relays and contacts and the development of new contact materials.

2.12 The project would include US$4.0 million of equipment (excluding contingencies) for the EMRD to be financed by the Bank. The equipment list has been reviewed and approved by the Research Review and Appraisal Committee of KERI to ensure its relevance to the future needs of electrical materials R&D. The EMRD is expanding its three laboratories to five. The present Insulating Materials Laboratory will be split into polymer and ceramics insulating materials laboratories. Similarly the Conductive and Magnetic Materials Laboratory will be split into conductive and magnetic materials laboratories. The fifth laboratory is for cryogenics research and will retain its present structure. New buildings are planned for the expansion of EMRD and will be completed in 1989-90. The new laboratory space for the installation of project equipment is estimated to cost US$1.4 million excluding contingencies. The project would also finance the costs of transportation and installation of equipment, consumable materials and O&M expenditures related to the equipment.

III. PROJECT COSTS, FINANCING AND IMPLEMENTATION

A. Costs

3.1 The total cost of the project is estimated at US$30.0 million equivalent net of duties and taxes. The estimated cost by project component is summarized in Table 3.1 and by category of expenditure in Table 3.2. Detailed costs by component and category are given in Annex 4 and project expenditure by year and purpose in Annex 5.

Table 3.1: SUMMARY OF PROJECT COSTS BY COMPONENT

	Won Billion			US$ Million			Foreign as % of Total
	Local	Foreign	Total	Local	Foreign	Total	
Korea Institute of Technology	1.6	3.5	5.1	2.5	5.4	7.9	68
Industrial Technology Center	2.3	5.7	8.0	3.7	8.6	12.3	70
Korea Electrotechnology Research Institute	1.2	2.6	3.8	1.9	4.0	5.9	68
Baseline cost	5.1	11.8	16.9	8.1	18.0	26.1	69
Contingencies							
Physical	0.5	1.2	1.7	0.9	1.8	2.7	67
Price increase	0.3	0.6	0.9	0.3	0.9	1.2	75
Subtotal	0.8	1.8	2.6	1.2	2.7	3.9	69
Total Project Cost /a	5.9	13.6	19.5	9.3	20.7	30.0	69

/a Does not include duties, taxes and fees estimated at US$1.5 million.

Table 3.2: SUMMARY OF PROJECT COSTS BY CATEGORY OF EXPENDITURE

	Won Million			US$ Million			Foreign as % of Total
	Local	Foreign	Total	Local	Foreign	Total	
Equipment	-	10,660	10,660	-	16.4	16.4	100
Equipment transportation & installation	622	69	691	1.0	0.1	1.1	9
Civil Works	4,330	1,005	5,335	6.7	1.5	8.2	18
Operation and maintenance	104	12	116	0.2	-	0.2	0
Consumable materials	104	12	116	0.2	-	0.2	0
Baseline costs	5,160	11,758	16,918	8.1	18.0	26.1	69
Contingencies							
Physical	516	1,176	1,692	0.9	1.8	2.7	67
Price increase	268	600	868	0.3	0.9	1.2	75
Subtotal	784	1,776	2,560	1.2	2.7	3.9	69
Total project cost	5,944	13,534	19,478	9.3	20.7	30.0	69

3.2 Base costs are estimated at January 1989 prices. Construction costs were provided by the Government and are based on contract awards for similar facilities in Korea. Equipment costs are estimated on the basis of master lists already drawn up and recent catalogue prices. Transportation and installation costs are based on recent experience with these activities in the project institutions. The initial supply of consumables has been estimated at 1% of equipment costs excluding contingencies. Operation and maintenance costs for equipment were also estimated at 1% of investment costs. Duties and taxes, allowing for exemptions, are estimated at US$1.5 million. During negotiations the Government gave assurances that adequate funds would be available to cover all duties, taxes and fees related to equipment to be imported under the project.

3.3 The contingency allowance of US$3.9 million (about 15% of baseline costs) includes contingencies for unforeseen physical conditions and for estimated price increases. Physical contingencies were estimated at 10% of baseline costs for civil works, equipment, consumable materials and O&M expenditures. Price increase contingencies were calculated for both local and foreign costs in accordance with the following expected annual average price increase percentages:

	FY89	90	91	92
Foreign	5	4	4	4
Local	2	2	2	2

Accordingly, aggregated price increases are estimated at about 4.3% of baseline costs plus physical contingencies.

3.4 The foreign exchange component of US$20.7 million (about 69% of total estimated project costs) has been calculated on the basis of the following foreign exchange percentages: civil works - 20%, equipment - 100%, transportation and installation - 10%, consumables - 10%, and O&M - 10%.

B. Financing

3.5 The proposed loan of US$16.4 million equivalent would finance about 79% of the estimated foreign exchange cost of the project or about 55% of total project costs net of duties and taxes. The Government would be responsible for the remaining 45% or about US$13.6 million equivalent. The loan amount is limited to US$16.4 million by the foreign borrowing program and is therefore less than the foreign exchange cost of the project. The loan would finance 100% of the baseline cost of equipment with all contingencies to be financed by the Government.

Table 3.3: FINANCING PLAN

Category of Expenditure	Government	IBRD	Total
	----------US$ million----------		
Equipment	-	16.4	16.4
Equipment transportation and installation	1.1	-	1.1
Construction	8.2	-	8.2
Operation and maintenance	0.2	-	0.2
Consumable materials	0.2	-	0.2
Contingencies	3.9	-	3.9
Total	13.6	16.4	30.0

Recurrent Expenditures

3.6 The project would not generate any significant additional recurrent expenditures. No additional staff would be required to utilize the equipment. The only incremental recurrent expenditures generated when the project is fully operational would be for consumables and operation and maintenance. These will amount to about US$0.3 million p.a. which represents about 0.6% of the estimated combined recurrent budgets of the three project institutions in 1991. These additional expenditures can be accommodated by the institutions without difficulty.

C. Project Management and Implementation

3.7 Each project institution would be responsible for the implementation of its part of the project. The institutions are autonomous bodies managing their own operations under the general budgetary oversight of the Ministry of Science and Technology. Thus MOST would play only an overall coordinating role in project implementation. It would not become involved in day-to-day implementation activities but would be kept informed by the Bank and the institutions on the general progress of project implementation. MOST would become involved directly only in project-wide issues which would require a coordinated response from the three institutions such as any proposed amendment to the loan agreement, change of project description, preparation of the project completion report, etc.

3.8 The project institutions are adequately staffed with experienced personnel in accounting and procurement although they have not yet had exposure to Bank implementation procedures. However, the bulk of the work in equipment procurement would be undertaken by the Office of Supply, Republic of Korea (OSROK), the procurement agency of the Government which is highly experienced in procuring equipment under the Bank's international competitive bidding procedures. On the basis of equipment specifications provided by the institutions, OSROK would prepare bidding documents, invite bids, evaluate them in conjunction with the institutions and make contract awards with the agreement of the institutions.

3.9 Implementation of the KIT component would be undertaken by the Office of Planning and Management (OPM) (Annex 1) which is responsible for KIT's development of physical facilities and equipment acquisition (in conjunction with OSROK). Support to OPM in accounting and general administrative matters would be provided by the Office of Business and Finance (OBF). The Director of OPM has been designated project director and would coordinate activities between OPM, OBF and OSROK. Similarly, project implementation at ITC would be the responsibility of the Office of Planning which is responsible for physical facilities development and equipment acquisition with accounting and administrative support being provided by the Administrative Office (Annex 2). The Director of the Office of Planning has been designated project director. At KERI, the Director of the Planning and Coordination Division would be project director (Annex 3). His division is responsible for physical facilities development and equipment acquisition and he would utilize accounting and other support staff from the General Administration Division.

Status of Project Preparation

3.10 The physical facilities required to house the equipment to be procured under the project are part of ongoing expansion programs in the three institutions and contracts are already in force for construction under these programs. The remaining 5% of the physical facilities for KIT will be completed in 1990; the new buildings for ITC in early 1990; and the two new laboratories at KERI in 1989-90. Equipment lists and specifications for the three institutions have been prepared and are acceptable to the Bank. Schedules of procurement by year have also been prepared by the project institutions. Project management authorities have been identified within the

project institutions and supporting implementation staff are also available. The advanced stage of project preparation will allow implementation to commence immediately after loan signing.

Procurement

3.11 Procurement arrangements are shown in Table 3.4. Civil works, to be financed by the Government, would be procured through established local competitive bidding procedures which are acceptable to the Bank. About 85% of the equipment would be procured on the basis of international competitive bidding procedures in accordance with the Bank's guidelines. Equipment items in contracts valued at less than US$200,000 may be procured through international or local shopping up to a limit of US$2.4 million. Local equipment manufacturers would be extended a 15% preference margin, or the prevailing customs duties, whichever is the lower, on bid evaluation under ICB. Transportation, operation and maintenance costs on equipment will be financed by the Government under local procedures. Installation costs and costs of consumables, if not included in the equipment contracts, would also be financed by the Government.

Table 3.4: PROJECT EXPENDITURE BY PROCUREMENT CATEGORY

Category of expenditure	ICB	LCB	Other	/a N/A	Total cost including contingencies
			(US$ million)		
Equipment	16.4 (14.2)	-	2.7 (2.2)	-	19.1 (16.4)
Equipment transportation and installation	-	-	-	1.2 (0.0)	1.2 (0.0)
Civil works	-	9.3 (0.0)	-	-	9.3 (0.0)
Operation and maintenance	-	-	-	0.2 (0.0)	0.2 (0.0)
Consumable materials	-	-	-	0.2 (0.0)	0.2 (0.0)
Total	16.4 (14.2)	9.3 (0.0)	2.7 (2.2)	1.6 (0.0)	30.0 (16.4)

/a Includes international and local shopping.

Note: Figures in parentheses are the amounts to be financed by the loan.

3.12 In accordance with successful practices for procurement under ICB used in the last two education projects in Korea (Loans 1800-KO and 2427-KO), OSROK will not be required to refer about 260 equipment contracts to the Bank for prior review before making contract awards. Bid evaluation reports, documents and contracts will be retained by OSROK for selected ex-post review by Bank missions. However, complete bidding documents including commercial terms, schedule of requirements and technical specifications will be sent to the Bank for reference and record before each invitation to bid.

Disbursements

3.13 The proposed loan of US$16.4 million would be disbursed over a period of 3.5 years (Annex 7). This is less than the standard disbursement profile for education projects in Korea which is 5.5 years. The proposed shorter profile is justified on the basis of the advanced stage of project preparation (para. 3.10) and the long experience OSROK has had in procuring equipment under the Bank's ICB procedures. The completion date of the project would be June 30, 1992 and the closing date December 31, 1992. Disbursements would be made on the basis of (a) 100% of foreign expenditures for imported equipment or the ex-factory cost of locally manufactured equipment; and (b) 65% of the cost of other local expenditures for equipment. For reimbursement applications involving equipment contracts exceeding US$100,000, two copies of the contract would be submitted to the Bank for review. For equipment contracts below US$100,000, reimbursement would be made against statements of expenditure for which full supporting documentation would be retained in the project institutions, for review as requested, by visiting Bank missions.

3.14 To facilitate disbursements, special accounts, maintained in US dollars, would be set up separately for KIT, ITC and KERI at the Korea Exchange Bank in amounts of US$600,000, US$800,000 and US$400,000 respectively. These amounts represent the estimated average amount required to finance project expenditures for the next four months. Applications for replenishment of each special account would be submitted to the Bank quarterly, or more frequently if necessary, in amounts of not less than US$200,000. During negotiations, the Government agreed that opening the special accounts for KIT, ITC and KERI would be a condition of disbursement under their respective categories.

Accounts, Audits and Reporting

3.15 The Government would cause KIT, ITC and KERI to maintain separate accounts in accordance with sound accounting practices. During negotiations the Government gave assurances that audited accounts and financial statements, including a separate audit of statements of expenditure would be sent to the Bank within six months of the end of the financial year. The Government also agreed during negotiations to submit semi-annual progress reports to the Bank, provide status reports for visiting missions and, within six months of the closing date, a project completion report.

D. Environmental Impact

3.16 The project will not have any negative impact on the environment. The equipment to be supplied under the project will be housed in properly designed laboratories. The Explosion Proof Testing System will be located in a specially designed building to ensure against possible environmental problems.

E. Impact on Women

3.17 The project would have little direct impact on the status of women. KIT, which is an educational institution and therefore the project institution most relevant to the status of women, has a current female enrollment of about 10%. This low enrollment level reflects the traditional reluctance of women in Korea to enter technology (only about 4% of enrollments in engineering programs nationally are female compared with 40% in natural sciences). In response, KIT has introduced a program aimed at attracting more women students. This consists of visits by faculty to girls' high schools, information packages for parents and student counsellors and visits by female students to KIT.

IV. BENEFITS AND RISKS

A. Benefits

4.1 The project would raise the quality of science and engineering education at KIT. This in turn would raise the quality of inputs to graduate programs at KAIST and ultimately benefit technology-intensive industry. The project would also strengthen the capacity of ITC and KERI to provide technical support services to SMIs which would result in expanded and more efficient utilization of scarce technical manpower and improve the quality of products. The SMIs would serve more effectively as suppliers of parts and materials to large enterprises thus reducing imports. The export capacity of the SMIs would also be enhanced under the project.

B. Risks

4.2 There are no major risks associated with the project.

V. AGREEMENTS REACHED AND RECOMMENDATION

5.1 During negotiations the Government agreed to the following:

(a) adequate funds would be available to cover all duties, taxes and fees related to equipment to be imported under the project (para. 3.2);

(b) KIT, ITC and KERI would each open a special account prior to disbursement (para. 3.14);

(c) audit reports would be submitted by the Government to the Bank within six months of the end of each financial year (para. 3.15);

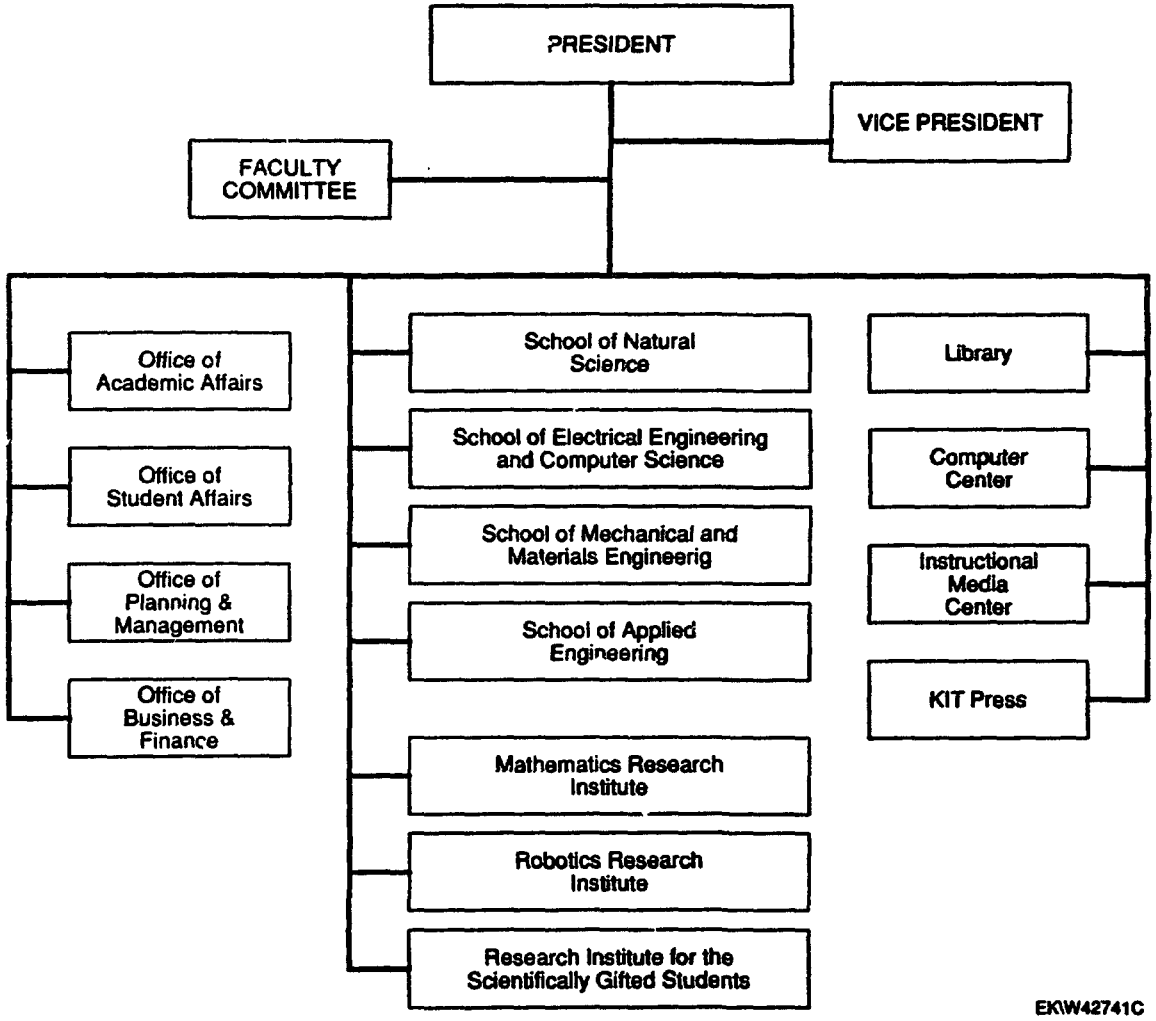
(d) semi-annual progress reports would be submitted to the Bank and status reports provided to visiting missions (para. 3.15); and

(e) within six months of the closing date, a project completion report would be submitted to the Bank (para. 3.15).

5.2 Subject to the above conditions, the project constitutes a suitable basis for a Bank loan of US$16.4 million equivalent to the Republic of Korea for a term of 15 years, including 5 years of grace at the Bank's standard variable interest rate.

KOREA
TECHNOLOGY ADVANCEMENT PROJECT
Organization Chart

KOREA INSTITUTE OF TECHNOLOGY



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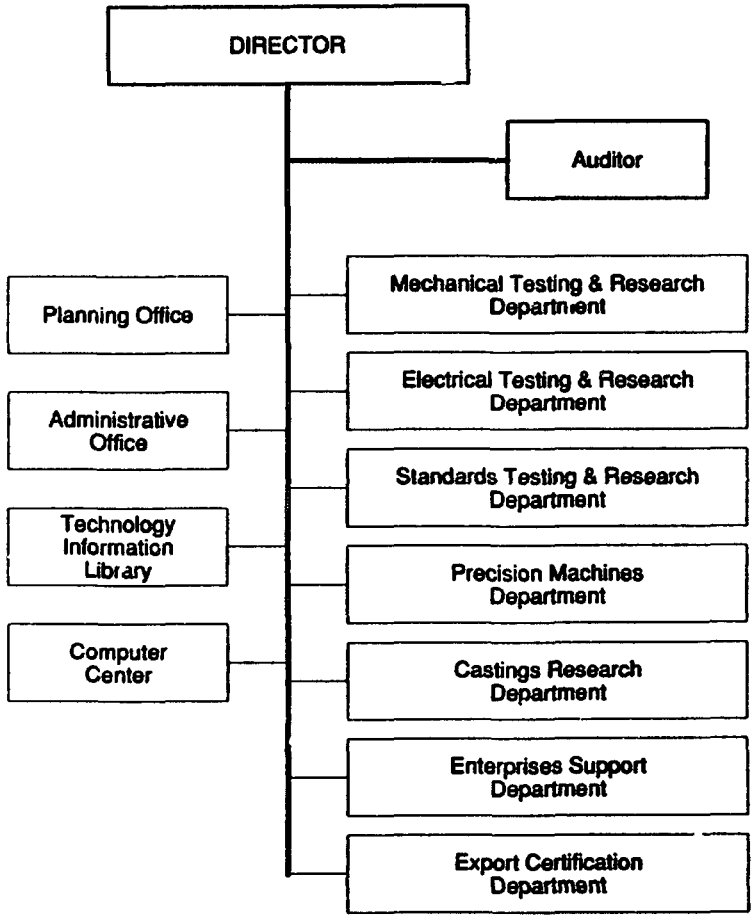
ANNEX 1

KOREA
TECHNOLOGY ADVANCEMENT PROJECT
Organization Chart

INDUSTRIAL TECHNOLOGY CENTER



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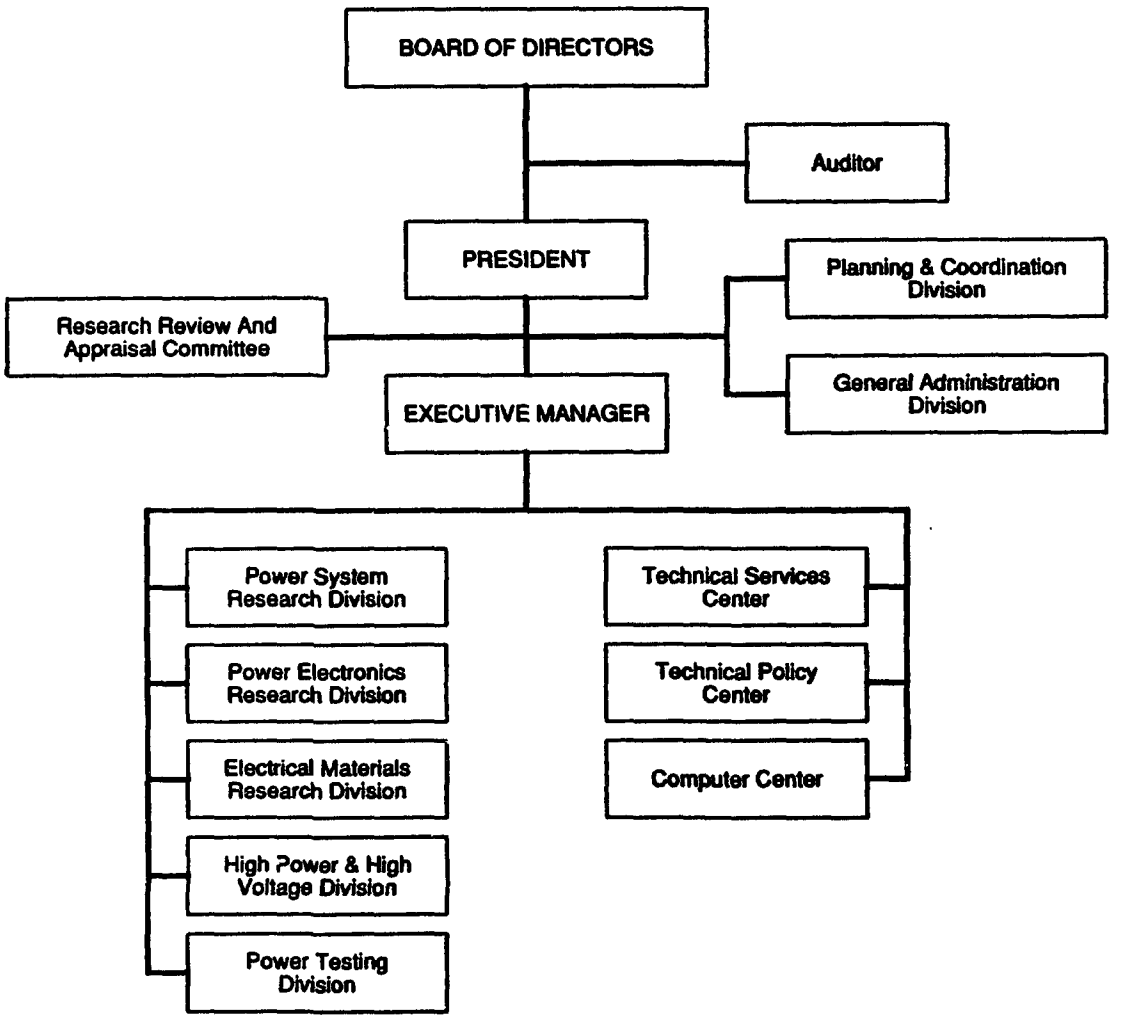
ANNEX 2

KOREA
TECHNOLOGY ADVANCEMENT PROJECT
Organization Chart

KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE



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ANNEX 3

ANNEX 4

KOREA

TECHNOLOGY ADVANCEMENT PROJECT

Detailed Project Costs
(Won million)

	Equipment	Equipment Transportation & Installation	Civil Works	O&M	Consumable Materials	Total Cost Won M	Total Cost US$ M
Korea Institute of Technology	3,510	227	1,316	38	38	5,129	7.9
Industrial Technology Center	4,550	295	3,077	49	49	8,020	12.3
Korea Electrotechnology Research Institute	2,600	169	944	28	28	3,769	5.9
Baseline cost	10,660	691	5,337	115	115	16,918	26.1
Contingencies							
Physical	1,066	69	533	12	12	1,692	2.7
Price increase	690	25	145	4	4	868	1.2
Subtotal contingencies	1,756	94	678	16	16	2,560	3.9
Total project cost							
Won million	12,416	785	6,015	131	131	19,478	
US$ million	19.1	1.2	9.3	0.2	0.2		30.0

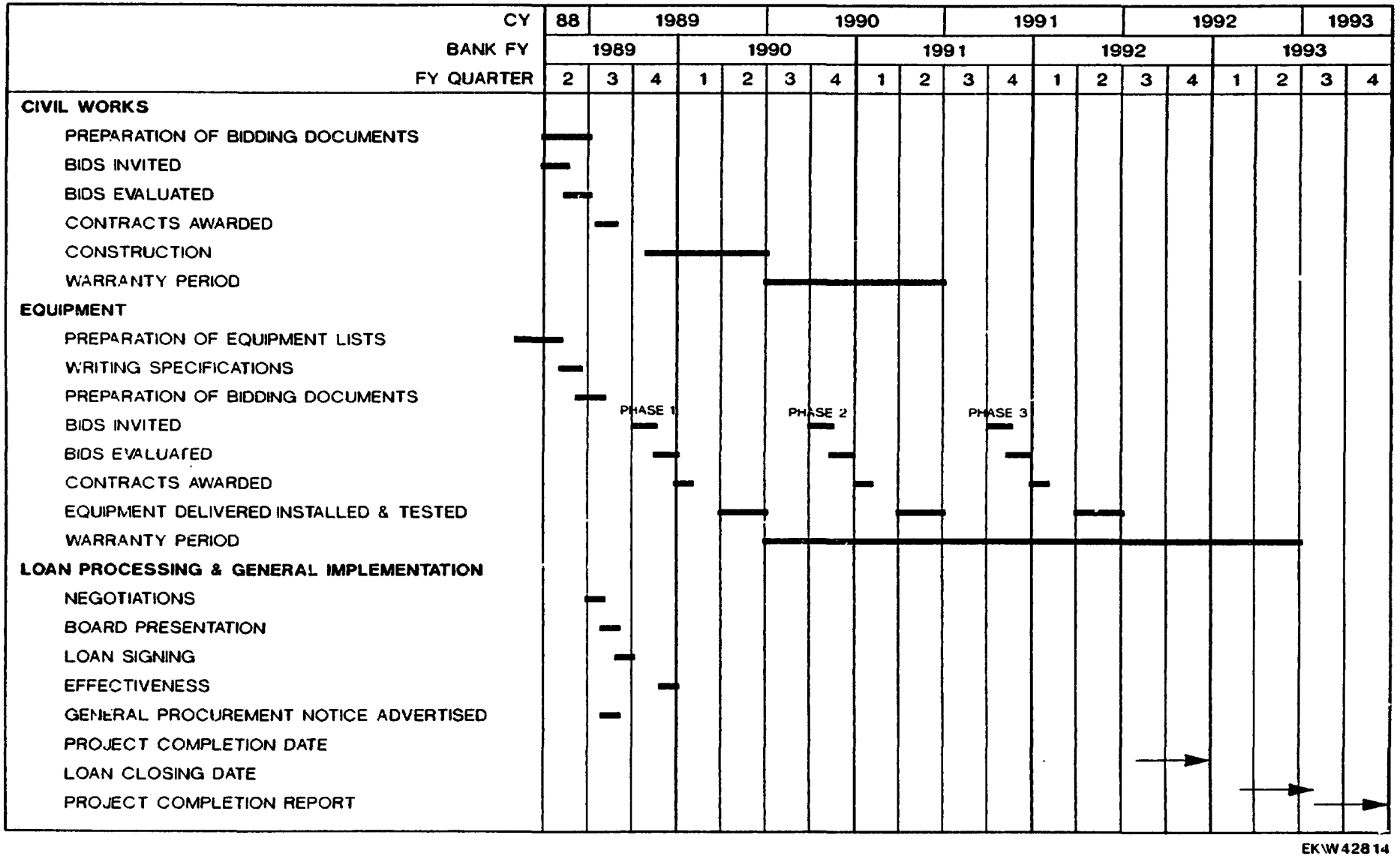
KOREA

TECHNOLOGY ADVANCEMENT PROJECT

Project Expenditure by Year and Purpose

	Base Costs (Won million)			Total Cost	
	89/90	90/91	91/92	Won M	US$ M
Korea Institute of Technology	1,407	2,179	1,543	5,129	7.9
Industrial Technology Center	3,152	3,203	1,665	8,020	12.3
Korea Electrotechnology Research Center	1,856	1,141	772	3,769	5.9
Baseline cost	6,415	6,523	3,980	16,918	26.1
Contingencies					
Physical	642	652	398	1,692	2.7
Price increase	110	342	416	868	1.2
Total Project Cost	7,167	7,517	4,794	19,478	30.0

KOREA
TECHNOLOGY ADVANCEMENT PROJECT
Implementation Schedule



ANNEX 6

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KOREA

TECHNOLOGY ADVANCEMENT PROJECT

Disbursements

IBRD fiscal year & semester	Amount per semester	Cumulative Amount (US$ million)	Cumulative %	Disbursement profile /a (%)
1990				
1	1.8 /b	1.8	11	1
2	3.6	5.4	33	3
1991				
1	3.6	9.0	55	5
2	2.2	11.2	68	10
1992				
1	2.2	13.4	82	23
2	2.2	15.6	95	44
1993				
1	0.8	16.4	100	70
2				81
1994				
1				92
2				97
1995				
1				100

/a Standard disbursement profile for education projects in Korea.

/b Initial deposit in Special Account.

KOREA

TECHNOLOGY ADVANCEMENT PROJECT

Selected Documents Available in the Project File

A. Reports and Studies Related to the Sector/Subsector

A-1 Introduction to Science & Technology - Republic of Korea, MOST, 1988

A-2 Science and Technology Handbook, MOST, 1987

A-3 A Study on the Long Term Development Plan of Graduate Education in the Field of Science and Engineering in Korea, MOE, July 1985

A-4 Industrial and Technology Policy for the Sixth Five-Year Plan Period, Kyoung-Hwie Mihn, KIET, September 1985

A-5 Korea - Managing Industrial Transition, 2 vols. IBRD, March 1987

A-6 Korea - Sector Survey of Science Education, IBRD, January 12, 1982

A-7 Impact of World Bank Lending for Educational Development in Korea: A Review, IBRD Report No. 5950, December 5, 1985

B. Reports and Studies Related to the Project

B-1 Prior Investigation Report of a New Public Investment Program, ITC, September 1987

B-2 Project for Improving Research Facilities to Achieve Domestic Production of Electrical Materials, KERI, July 1987

B-3 Information Package for Appraisal of Project, ITC, June 1988

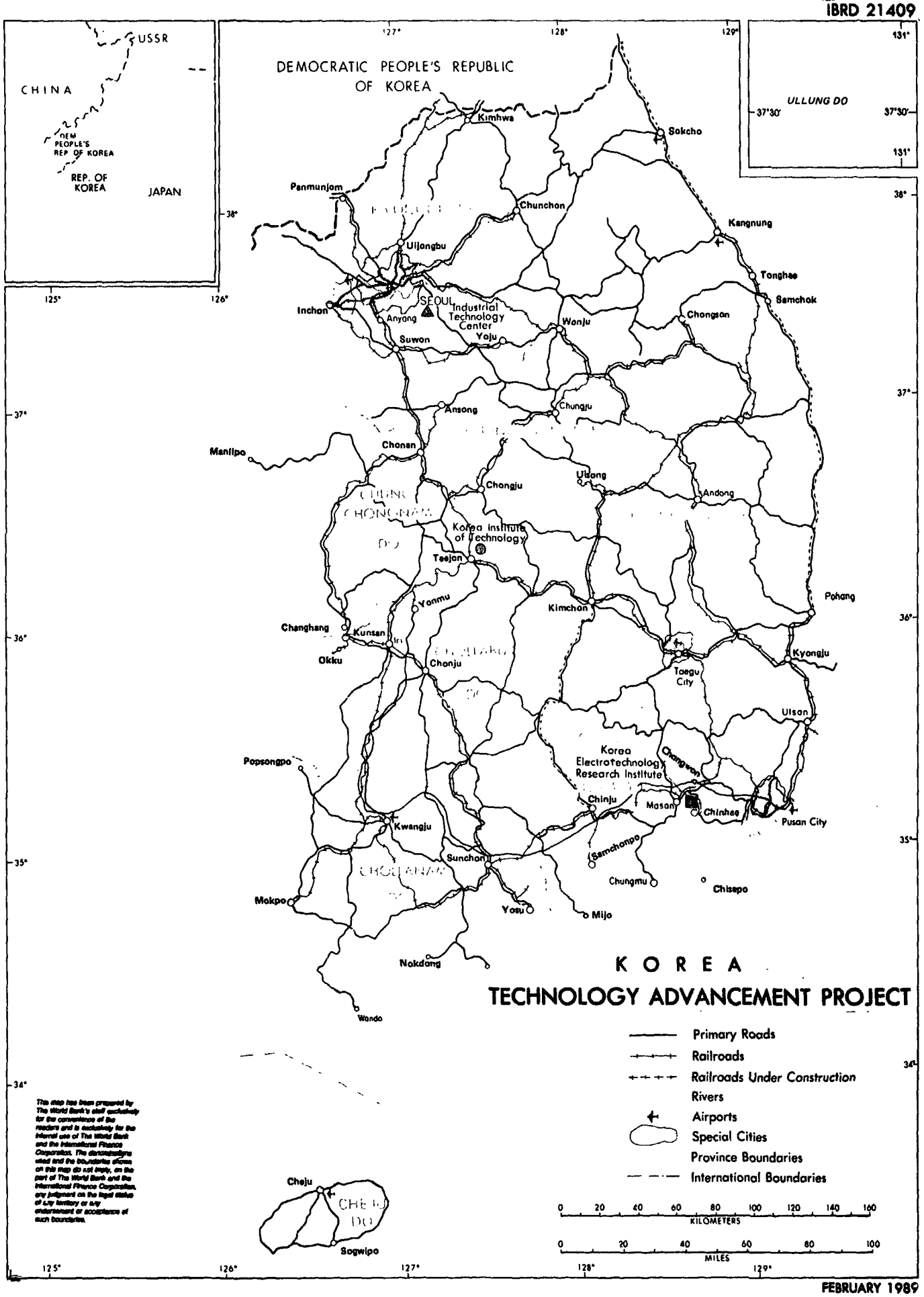
B-4 IBRD Loan Project for the Improvement of Educational and Research Capacity, KIT, June 1988

B-5 General Status and Prospective for Loan Programme, KERI, June 1988

C. Selected Working Papers

C-1 IBRD Working Paper - Equipment

IBRD 21409



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